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Non-stationary individual and household income of poor, rich and middle classes in Mexico

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HIGHLIGHTS

- Economic crisis on household income distributions in Mexico for years 1992–2008.
- Definition of three-class structure; poor, rich (Pareto) and middle classes.
- Adjusting income distributions to exponential, Log-normal or Gamma functions.
- Not very visible poor households or agents due to very low cut-off values.

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ABSTRACT

Despite Mexican peso crisis in 1994 followed by a severe economic recession, individual and household income distributions in the period 1992–2008 always exhibit a two-class structure; a highly fluctuating high-income class adjusted to a Pareto power-law distribution, and a low-income class (including poor and middle classes) adjusted to either Log-normal or Gamma distributions, where poor agents are defined as those with income below the maximum of the uni-modal distribution. Then the effects of crisis on the income distributions of the three classes are briefly analysed.

1. Introduction

Inequality in social systems has been a universal and robust phenomenon, not bound by either time or geography, but fortunately for scholars, it has a few statistical regularities, as in the case of income and wealth distributions over a wide range of societies and time periods [1–5]. For example, Pareto [6] made extensive studies in Europe and found that wealth distribution follows a power-law tail for the richer sections of society. In general, the upper end (the richer) of the income and wealth distributions is believed to be described by a power-law, as Pareto [6] argued over 100 years ago. Years later, Gibrat [7] found that not all income intervals follow a Pareto distribution, so he proposed a multiplicative stochastic process where the proportional rate of growth of a firm is independent of its absolute size, yielding a log-normal probability distribution function (PDF). Silva and Yakovenko [8] found that the data analysis of income distribution in the USA reveals coexistence

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of two social classes; the large lower class is characterized by the exponential Boltzmann–Gibbs (B–G) distribution, and the very small upper class exhibits the power-law Pareto distribution with characteristic fat tails. They found that the exponential distribution in the lower class is very stable in time for all years, since they collapse to a single curve after being adjusted to inflation, whereas the power-law distribution of the upper class is volatile. They claimed that the local conservation of money (energy) leads to the robust exponential (B–G) distribution in the large USA lower class. Although this conservation is just an approximation, the B–G analogy works very well in the low-income region, since all the yearly distributions collapse to a single curve after being adjusted to inflation. Since the (B–G) analogy allows transfers of all energy (or money) from an agent to another, then Chakrabarti and Chakraborti [9] extended the model to account for restrictions on transferred energy (savings), because we know that in real world it is unlikely that agents put into play or risk most of their money on a single economic negotiation, unlike what happens in collisions between particles when a particle can elastically yield all its kinetic energy to another. Within this context the Gamma function is a good fit for a model of constant saving factor fraction [9,10]. Incidentally, the Gamma function also appears in a utility maximization model [10] within a standard exchange-model employing Cobb–Douglas utility function. In summary as mentioned in Ref. [9], in general, the bulk of the low range of the distribution of both income and wealth in many societies seems to be well fitted by both log-normal and gamma distributions, for which the exponential term dominates for large values. Economists usually prefer the log-normal distribution [11], whereas statisticians and, more recently, physicists [2,3,9,12] tend to rely more on alternate forms such as the Gamma distribution for the probability density (PDF) or the Gibbs/exponential distribution for the complementary cumulative distribution (CCDF) [9]. An important recent study on US income distribution [13] claimed that the B–G and Pareto mixtures fit can be improved upon further by adding a Log-normal component.

On the other hand it is important to investigate less stable emergent economies, especially in times of economic crisis. In Mexico there was a strong depreciation of the currency at the end of 1994, which was followed by severe economic recession. Here, we analyse statistical information on income distribution of population provided by the national survey ENIGH of the national institute INEGI for the period 1992–2008. The layout of this work is the following. Section 2 is devoted to theory and empirical evidence of exponential-like (Gamma and Log-normal) and Pareto income distributions. In Section 3, for all years we estimate the demarcation income value for the exponential-like and Pareto mixture's fit distributions, and then we present the adjustments employing individual and household data. If we define poor (middle-class) agents as those with income below (above) the maximum of the uni-modal distribution, then the middle class population lies between that maximum and the Pareto rich class. Section 4 is devoted to conclusions.

2. Pareto and exponential-like (Log-normal and Gamma) distributions

Empirical income distribution in countries such as US [8], European Union [14] UK [15] and Canada [16], among others, presents a two-class structure, in the sense that most of the population of these countries or regions belong to a low class characterized by a distribution similar to an exponential function, while the highest follows a Pareto distribution (as was found by Pareto many years ago for a number countries). As mentioned in Ref. [9] in general, the low-income bulk of the distribution of both income and wealth seems to be fitted by either Log-normal or Gamma distributions. Similar results were found in US subgroups categorized by gender and race (Whites and African-Americans), confirming for the subgroups the same qualitative two-class income distribution [17]. In all these cases, the upper Pareto tail changes much more in time than the lower regions. Creation and destruction of money in complex processes (through investments, credit, financial derivatives, big stock market crisis, etcetera) are much more clearly related to the Pareto tail. For reviews on income and wealth distributions, see Refs. [3,9]. Let us review in some detail a particular case, the analysis income distribution in USA in the period 1983–2001 by Silva and Yakovenko [8]. The exponential distribution in the lower class was modelled by analogy to a thermodynamic phenomenon, by considering that conservation of money in economic interactions is similar to the conservation of kinetic energy in elastic collisions representing trade for goods and services. Since the exponential distribution in the lower class was shown to be very stable in time after inflation adjustment, whereas the power-law distribution of the upper class is highly dynamic and volatile, it was concluded that the lower class is in thermal equilibrium, and the upper class is out of it [8]. From the time evolution of the integrated wealth of people in the upper income Pareto tail in the period 1983 and 2001, they observed that this total Pareto wealth tail is more or less in phase with the stock market index S&P 500 divided by inflation. The S&P 500 is a capitalization-weighted index published by Standard & Poor's of the prices of 500 large market capitalization common stocks actively traded in the United States. That is, the Pareto wealth tail is correlated with the rise and fall of the stock market since it swells and shrinks following the stock market. This empirical fact shows that some of the mechanisms to make money followed by richest people are different from the majority of the population, which mostly exchange goods and services.

2.1. Power law or Pareto distributions

More than a century ago, the economist Vilfredo Pareto (1848–1923) found that wealth distribution follows a power law tail for the richer sections of society [6] following a probability distribution form, known now as the Pareto law [9]:

$$P(m) \propto m^{-\alpha} \tag{1}$$